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(54) Module to deal with, extend and repair undersea lines, worked by remotely operated vehicle.

(57) A connector module (1) to repair and extend undersea lines, is worked by remotely operated vehicle and consists of a metallic structure (2) which houses a loop (3) of pipe fitted at its ends at the front and back with valves worked by ROV and with forged connectors and having in its upper part a T branch-off fitted at its ends with valves worked by ROV and with forged connectors, said metallic structure being fitted laterally with hot-lines (9).

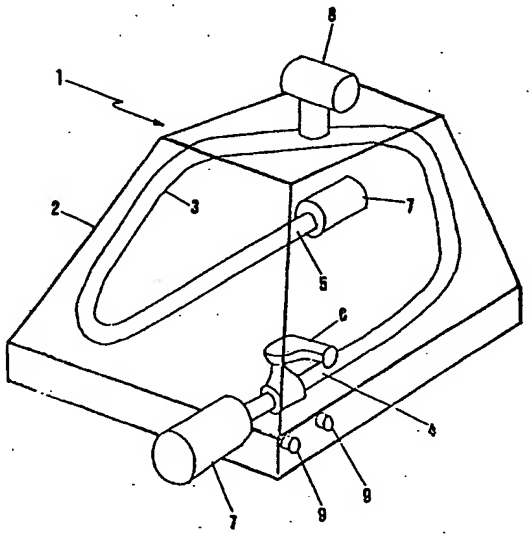

FIG 1

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A MODULE TO DEAL WITH, EXTEND AND REPAIR UNDERSEA LINES, WORKED BY REMOTELY OPERATED VEHICLE.

This invention concerns a system to deal with and extend and repair undersea lines to be worked on by remotely operated vehicles so as to enable oil, gas and hydrocarbons in general, flowing in a pipeline system laid below the reach of known conventional saturation diving methods, to be dealt with for repair, extension and maintenance purposes with the aid of remotely operated vehicles (ROVs) and suitable interfaces.

As is well known a great many pipelines running along the bottom of the sea are likely to have to undergo repairs because of damage of various kinds suffered by them; they may for instance be cut by anchors, there may be leakage of fluid from inside the lines because of welding flaws and also due to damage caused by a lack of cathodic or anti-corrosion protection.

Those well versed in this art also know that much has been done towards achieving a system to deal with the repair of undersea lines in a way sufficiently efficient to meet the requirements of well-known operators and concerns working in this field. Among the systems known and in development at present are:-

a) the "CAMERON" system, which makes use of a mechanical connector, cold forged at a pressure of about 1400 kg/cm^2, and it is used with some aid from divers or remotely operated vehicles acting only upon the pipe to be repaired, spreading it into the coupling grooves and aligning itself with the pipeline. When it is fixed on to the pipeline it also gives rise to a metal structure base which acts as a guide in the remedying of any fresh stretch of pipe, this being a system that might become part of a wider repair system;

b) The "SNAM" system which is an all-encompassing undersea pipeline repair system provided with accessories meant to clean, cut and align the pipeline with the aid of ROVs and a boat fitted with dynamic positioning. It makes use of a cold forging system along with deformation of pipe and connector, namely mechanical action, without use of any elastomers. Deformation takes place in both parts to be joined in that the pipe is expanded into the connector, which also expands, but the connector material tries to return to its former state more strongly than does the pipe, which adds to the effect of such action because of the different properties of the two metals. This system seals better than does the CAMERON forged connector system, since several interference grooves come into being, thereby increasing interaction of the bodies concerned. This system is disclosed in U.S. Patent 4.648.626 of March 10, 1987.

c) The "ALSTHOM" system is a fully designed system provided with accessories to cut and to clean both inside and outside to remove concrete and casing and employs a mechanical connector, only the end of the pipe being cold forged. The collar so formed provides the metal-to-metal seal with the connector and use is made of a forging process which is more complicated and less reliable in terms of average and long term life than for the CAMERON and SNAM systems previously referred to;

d) The "HYDROTEC" system makes use of Atmospheric Diving System (ADS) diving gear belonging to "Oceaneering". This system employs mechanical connectors adjusted with the aid of a manipulator - BMF (Bottom Manipulating Frame);

e) The "ELF EQUITAINE" system is one that is part of, and further to, the "ALSTHOM" system referred to above. Mechanical connectors are used and they are laid on pipes that have had cold forging treatment;

f) The "IRDS" (International Robotics Diving System) system which uses the undersea pipeline aligning and repair supporting THOR system, which has many accessories that make it quite a practical system, the connecting and/or repairs being done by TIG orbital welding which requires the aid of divers.

From the foregoing it will be concluded that the present trend is to rely ever-increasingly on the use of mechanical connectors, which are able to remedy evaluations, take up misalignments, and even be reused if wanted. The disadvantage of such technique is that certain kinds of connectors employ gaskets and/or elastomers for sealing purposes, and these are likely to age and even to leak after some time.

Furthermore, in spite of hyperbaric welding having been made use of for the great number of undersea pipeline repairs done up to now, it is the general opinion that, in addition to being complicated because of the safety of the men engaged in such work, repairs carried out with this technique also seriously curb any automation of the process because of the environmental factors that directly affect the quality and the final result of the repairs done. It is generally acknowledged that repairs which follow this technique are hardly feasible in deep waters (400 m) without the aid of divers, which means that repairs done with mechanical

connectors are to be preferred in deep waters since they are more easily automated.

This invention provides a system to intervene with to extend and to repair undersea pipelines which is worked by an ROV and which is meant for great depths in the sea, where it is impossible to work with divers, thus enabling a pipeline system in which oil, gas and hydrocarbons in general flow, but which is beyond the reach of known and conventional saturation diving methods, to be dealt with for repair, extension and maintenance purposes with the aid of ROVs and suitable interfaces.

Accordingly the invention provides a device for use in repairing or extending undersea lines, characterised by being a module including a pipe having connector means to connect the pipe to an undersea line to be repaired or extended, said pipe having ends at opposite ends of the module; by valves operative to close off said pipe; and by hot lines to allow a remotely operated vehicle (ROV) to be used to operate said valves and said connector means.

The invention provides for a system of integrated pipelines and connector modules, the connector modules being the heart of the system and consisting essentially of a metallic (modular) structure which houses a pipeline loop with a by-pass in its upper part and connectors fitted with valves at the ends thereof. The connector modules will be linked up to the ends of a previously laid pipeline or with a stretch of line to be repaired, loop ends as well as all other stretches of the pipeline being fitted with forged mechanically-operated connectors thus facilitating access to all connectors which match one another.

In the upper part of the connector module there may be a stand-by T branch-off to enable other connections to be made to the pipelines in operation whether needed as a hot-tap or whether because of some mishap to any either up- or downstream stretch of the line. Such a connector acts as a by-pass for a new stretch of pipe which, when connected to the stand-by T and after the appropriate valves have been operated, enables flow of product to resume promptly and the damaged stretch of pipe to be withdrawn and repaired. There is also the advantage of being able to repair or replace smaller lengths of pipe without there being any pressure there, while production flow still goes on.

With the aid of the presently proposed system the time needed to carry out repairs on a pipeline will become noticeably less, which means running costs will drop and, if desired, production can recommence much more swiftly than is usual thus bringing about substantial saving and improved safety for both plant and those who use it.

A further considerable advantage of the connector module is that not only does it make use of the tolerances claimed by the makers of the connectors already on the market but also the loop of pipe inside the metal structure can be shifted in three ways by hydraulic devices, which means that the ends thereof can be adjusted in three dimensions and not only just rectilinearly as in the existing systems. This leads to a volume within which remaining pipe ends can be adjusted as required and all misalignments, whether axial, longitudinal, or elevational are taken up.

Other objects, features and advantages of this invention will now be made clearer from the following description given with reference to the accompanying drawings in which:-

Figure 1 is an enlarged perspective view showing the connector module used in the system of this invention;

Figure 2 is an enlarged front view of the connector module shown in Figure 1;

Figure 3 is a diminished perspective view of the metal structure of the connector module, showing the hydraulic devices which enable three-dimensional adjustment of the ends thereof;

Figure 4 shows how replacement in an undersea pipeline (the major purpose of the intended system) takes place by use of the connector module of the present invention; and

Figure 5 shows how a damaged stretch can be replaced, and a new one put in, within a system incorporating this invention from the outset.

As is to be seen from the Figures, this system of dealing with, and extending and repairing undersea lines, with the aid of an ROV means that the undersea pipeline has to be provided with connector modules consisting of a metal (modular) structure 2 made of a substance, preferably carbon steel, suitable for the environment concerned. A loop of pipe 3, preferably made of special steel, or being a flexible pipe, is housed on the structure 2 and has forward 4 and rear 5 ends which are fitted with valves 6 worked by an ROV and forged connectors 7. The upper part of the structure 2 is fitted with an optional stand-by T branch-off, and the metallic structure 2 is also provided laterally with hot-lines 9 through which to apply hydraulic signals to work the hydraulic devices 18, 19, 20 (Figure 3) which enable three-dimensional adjustment of each of the pipe ends of the connector module 1 to take place.

It should also be pointed out that, although not shown in Figures 1 and 2, the end 5 of the pipe 3 at the rear of the module has a valve upstream of the forged connector 7 and is operated by an ROV by way of a hot line; also, the stand-by T branch-off 8 has at its end valves which are to be operated by such ROV by way of hot lines, and has forged connectors.

Figure 4 shows how a damaged stretch of undersea pipeline is replaced with the aid of a connector module system of this invention, dropped off from a ship. Figure 4 shows production platforms 10 and 11 and risk zones 12 and 13. The job of replacing part of such undersea pipeline 14 takes place in the following stages:-

a) pipeline 14 is drained of fluid and purged;
b) the damaged stretch is withdrawn;
c) ends are prepared and forged connectors 15, 16 are installed;
d) a connector module 17 with ends already adjusted is dropped;
e) a first alignment of the connector module 17 with the ends 15, 16 of the line takes place, with the aid of pre-established guides;
f) the hydraulic drive of the connector module is operated by ROV to effect fine adjustment 18, 19, 20 (Figure 3) of the coupling at one end of the module, horizontally (18), vertically (19), and longitudinally (20);
g) the ROV operates the mechanism of the connector means to close at that end;
h) the same procedure (steps f and g) takes place at the other end of the module by means of a second set of hydraulic adjustment means connected to hot lines (not shown) on the other side of the module (1);
i) connectors are tested;
j) pigs are run through; and
k) the pipeline resumes operation.

Figure 5 shows a further advantage of the present system when fitted with two connector modules 21 to change a stretch of damaged undersea line. Like Figures 1 and 2, Figure 5 does not show the forward and rear ends of the loop of pipe, nor the ends of the T branch-off of the connector module, as being fitted with valves worked by an ROV and does not show the forged connectors. This Figure does show production platforms 22 and 23, risk zones 24 and 25, an emergency by-pass 26, the undersea pipeline 27 and the damaged area 28. The stages in the changing of a damaged undersea line within a system already fitted with such components will now be given:-

a) the damaged area 28 is found with the aid of the ROV;
b) valves at 29, 30 are shut with the aid of the ROV using the first set of hot lines of each module;
c) valves at 31 and 32 are closed with the aid of the ROV using the second set of hot lines;
d) emergency by-pass line 26 is dropped from the rig;
e) connections at 33 and 34 are made with the aid of the ROV;
f) valves at 29, 34, 33 and 30 are opened;
g) connectors at 31, 32 are disconnected in order to withdraw the damaged line, and then the line is hauled up.

Also, there is a third advantage in that when a new undersea line has to be added to a system already fitted with such components, or when a line has been for some reason fitted with a repair module as shown in Figure 5 where 35 is the new line and 36 the new well, such an operation is easily and efficiently carried out. All that is needed is to lay the fresh undersea line from the well 36, to link it up with the line at 33, to open valve 36 and to open valve 33.

The main feature of this invention is that pipe end misalignments can be taken up without the need for any large scale devices to move them back into their original position.

Claims

1. A device for use in repairing or extending undersea lines, characterised by being a module (1) including a pipe (3) having connector means to connect the pipe (3) to an undersea line to be repaired or extended, said pipe having ends at opposite ends of the module; by valves operative to close off said pipe; and by hot lines (9) to allow a remotely operated vehicle (ROV) to be used to operate said valves and said connector means.
2. A device according to claim 1, characterised in that said pipe (3) is looped in its extent between said opposite ends of the module.
3. A device according to claim 1 or 2, characterised in that said connector module (1) is provided with hydraulic means which enable each of said ends to be adjusted spacially in three dimensions.
4. A device according to claim 3, characterised in that said hydraulic means are worked by the remotely operated vehicle (ROV) by means of hot-lines (9) fitted laterally of said structure.
5. A device according to any one of the preceding claims characterised by the fact that the module (1) further has in its upper portion a stand-by T branch-off fitted at its end with valves to be worked by a remotely operated vehicle (ROV) and with connectors.
6. The use of a device according to any one of the preceding claims to repair a pipeline, characterised in that misalignment of pipe ends can be taken up without need for any large scale devices to bring displaced pipes back to their original position.

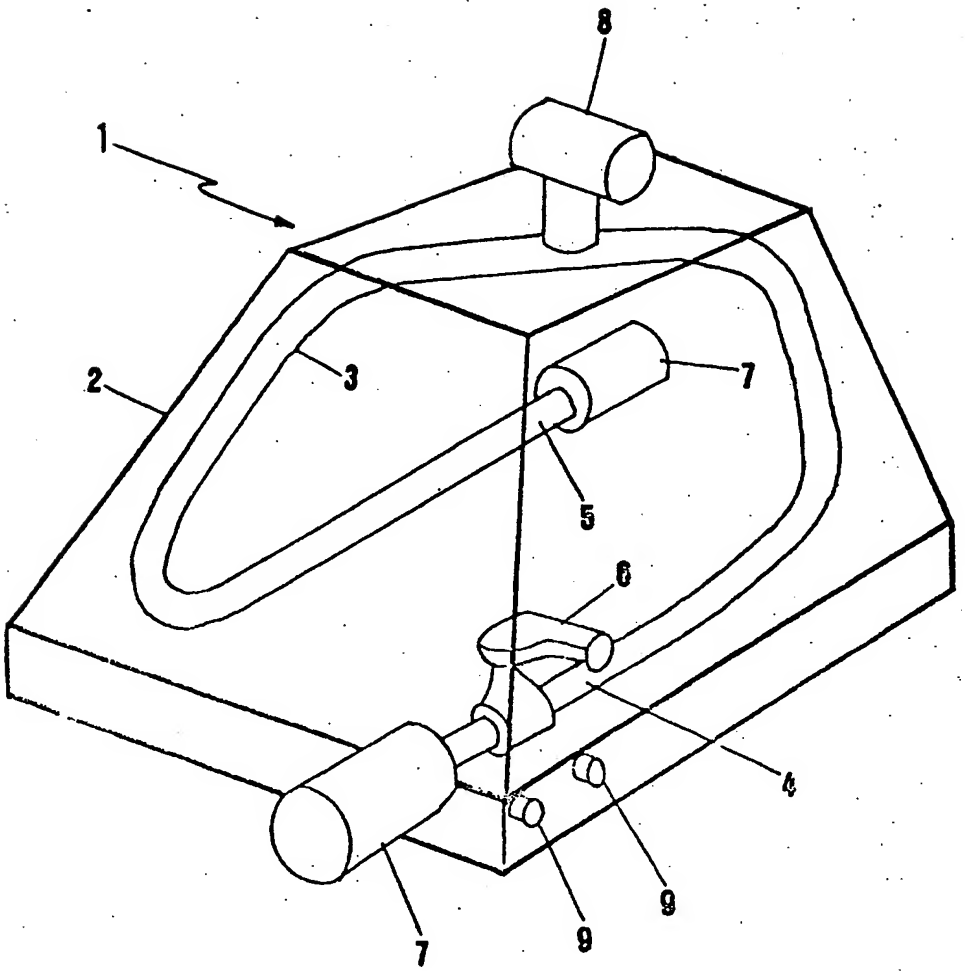

FIG 1

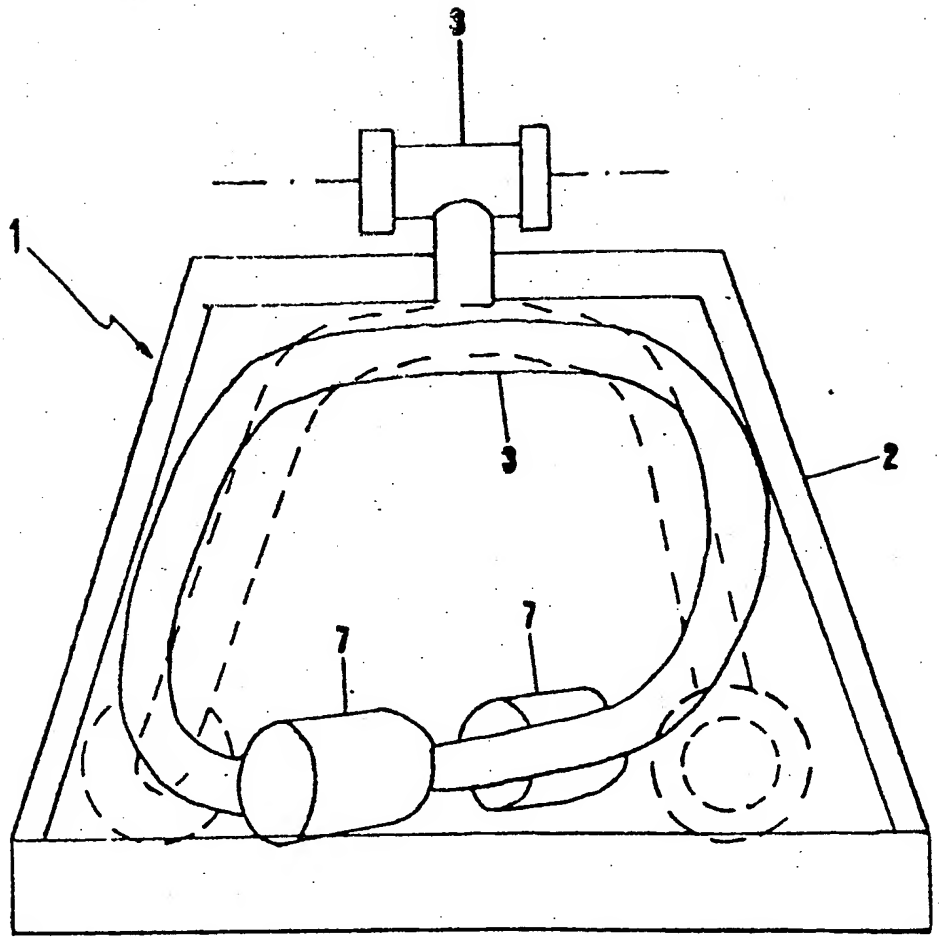

FIG 2

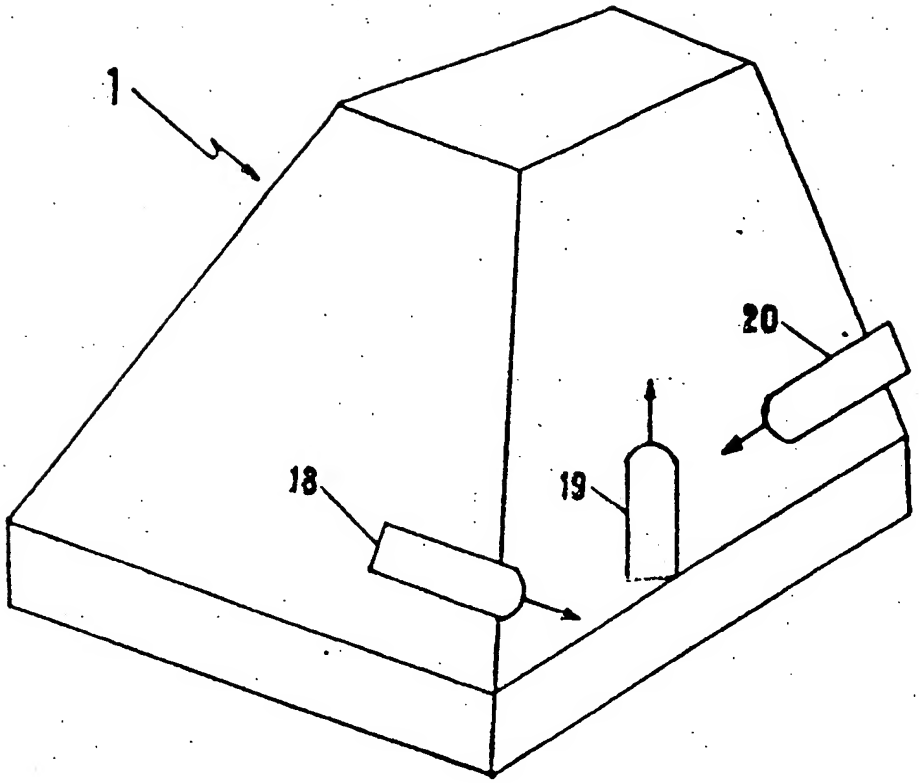

FIG 3

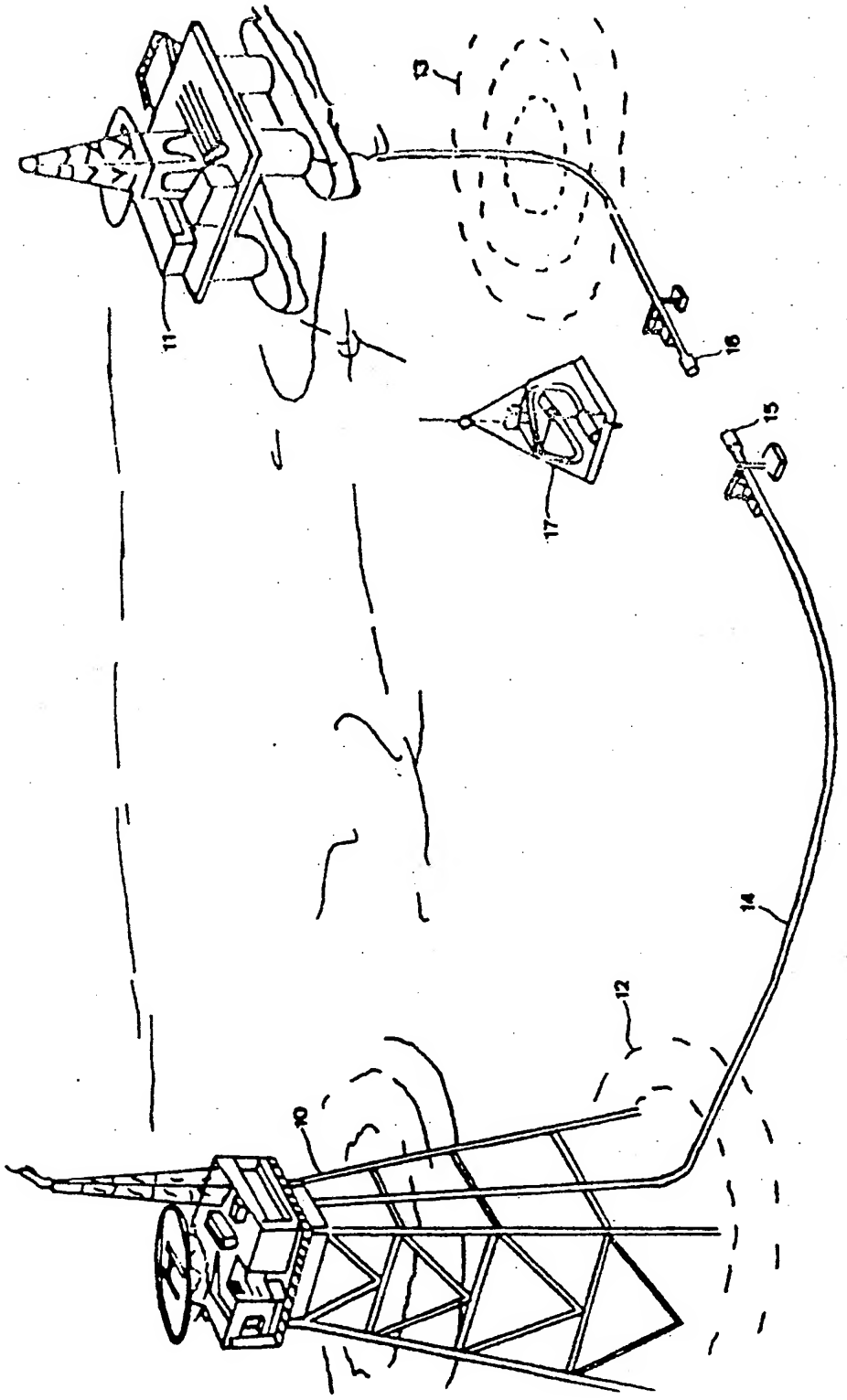

FIG4

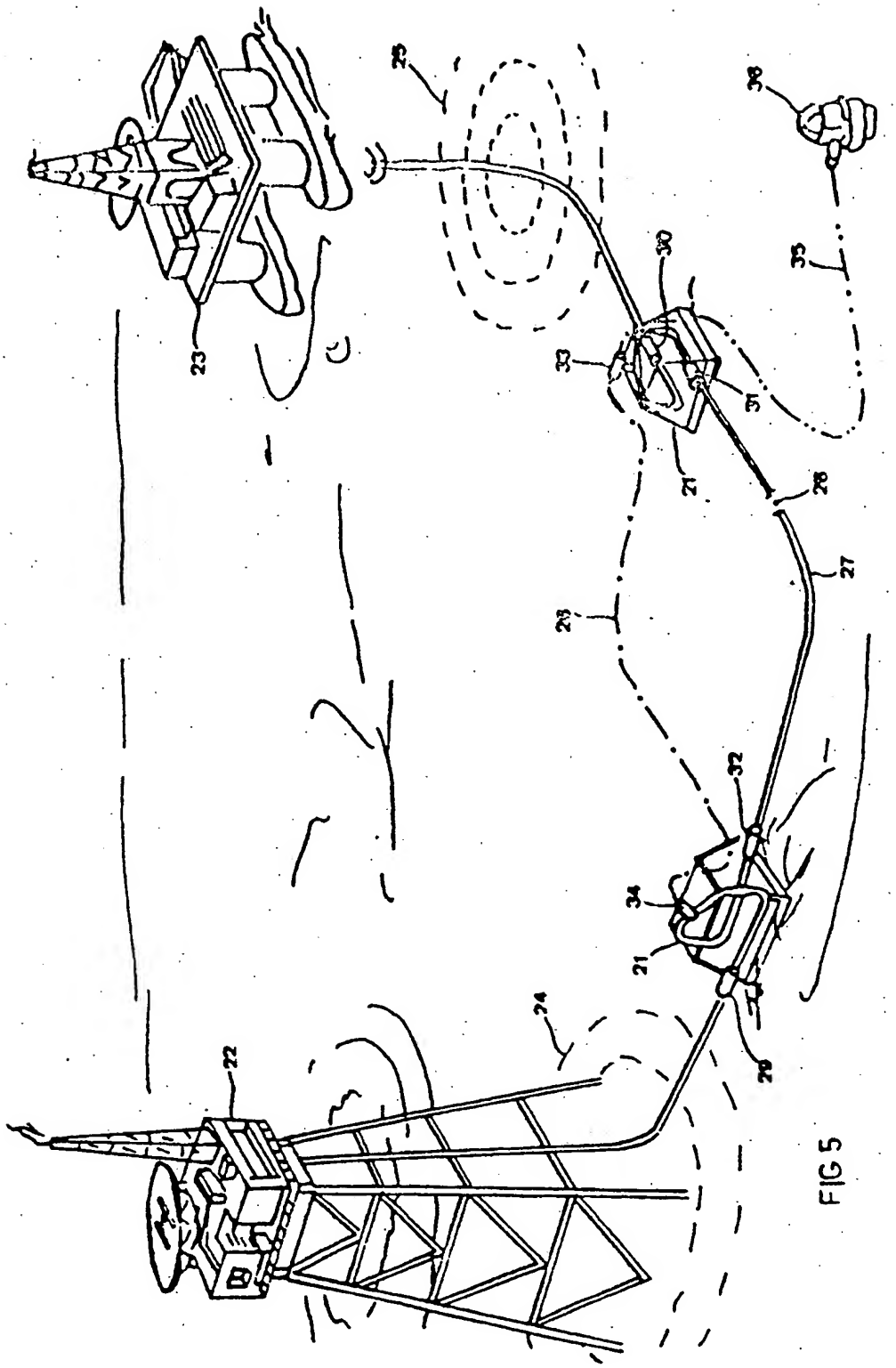

FIG 5